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Can high pressure processing extend the shelf life of fresh beef (#413)

Anita Sikes¹, Lesley Duffy¹, Alex Kanon¹, Joanne Hughes¹, Yutao Li²¹ CSIRO, Agriculture and Food, Coopers Plains, Australia; ² CSIRO, Agriculture and Food, St Lucia, Australia**Introduction**

It is well-established that high pressure processing (HPP) without heating effectively inactivates microorganisms in meat products, resulting in improved shelf life [1]. However, for improved shelf life, commercially applied pressure levels range between 400–600 MPa, and pressures at this level result in changes in the colour and appearance of fresh meat [2]. Hence this limits the usefulness of HPP for the extension of shelf life of fresh meat products. This work determined the pressure limits that can be applied to fresh meat for maintaining 'acceptable' colour, and the subsequent impact on shelf life.

Methods*Defining pressure threshold for colour stability*

Paired beef *longissimus lumborum* (LL) muscles were collected from 6 carcasses at 24 h post-mortem. Portions from each pair (30x30x120 mm, ~75 g) were allocated to treatments: pressure (0.1 MPa: untreated control, 100, 200, 300, 400, 500, 600 MPa) and pressure holding time (2, 5 min). High pressure was applied (Stansted Fluid Power 850 Mini FoodLab, 0.3 L, UK) at ambient temperature within 24–48 h post-mortem. Colorimetric measurements were recorded using a Minolta colorimeter CR-400 (illuminant D65, observer angle 2°, 8 mm aperture) and were used to determine the appropriate pressure for subsequent experiments. The effects of pressure treatment and treatment time was determined with a blocking structure of animal (GenStat 15th edition).

Verification of threshold pressure conditions and impact on shelf life

Beef LL muscles (n=18) were allocated to one of 3 pressures (0.1, 200 and 250 MPa), identified from the preliminary trial above, and 6 storage times (0, 4, 8, 12, 16 and 20 weeks). Vacuum packed portions (100x120x150 mm, ~1 kg) were subjected to HPP (QUINTUS Flow Pressure System, 35L-600) at ambient temperature for 2 min and stored vacuum packed at -1°C for the nominated storage times. Total viable counts (TVC) were determined on the external surface of samples using Petrifilm aerobic count plates. A Hunterlab Miniscan EZ 45/0 LAV (light source A, observer angle 10°, 25 mm viewed area) was used to measure L*, a* and b* values. A linear mixed model of analysis of variance was applied to identify the individual sources that impacted the attributes (SAS version 9.4).

Results

Visually, the muscle became 'lighter' in colour with increasing pressure up to 600 MPa (Fig. 1). From colorimetric data (Fig. 1, L* values), increasing pressure resulted in significant ($P < 0.001$) increases in L* values (lightness), with

L* values for samples treated with pressures of 200–600 MPa significantly higher than control and 100 MPa samples. Lightness was similar ($P > 0.05$) in samples treated at 2 or 5 min. A pressure threshold of 200–300 MPa was selected from the colorimetric data for the subsequent verification and shelf life study. These pressures were shown to result in an 'acceptable' fresh meat appearance,

Pressure treatment at 250 MPa generated a lighter (L* 45.06) product compared to the control (L* 39.97) and 200 MPa (L* 41.25) samples at all storage times ($P > 0.05$), and suggests that 200 MPa is a more suitable threshold pressure to maintain an 'acceptable' colour of fresh beef. TVC remained low ($< 7 \log_{10}$ CFU/cm²) across the 20 week storage period (Fig. 2). There was no significant ($P > 0.05$) difference in TVC between treatments, but at week 4, HPP appeared to delay growth (Table 1). However, this delay was temporary, and TVC was similar for all treatments from 8–20 weeks.

Conclusion

The pressure threshold to maintain an 'acceptable, fresh-like' appearance of chilled vacuum-packed beef *longissimus lumborum* was shown to be 200 MPa, applied at ambient temperature for 2 min. Although there was no difference in microbiological populations between HPP and untreated control treatments across the 20 week storage period, a delay in growth at 4 weeks storage with HPP indicates an application for potentially extending the retail display life of overwrap meat produced from pressure treated primals within this storage period.

Acknowledgments

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References

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- [2] Bak, K.H., Bolumar, T., Karlsson, A.H., Lindahl, G. & Orlien, V. (2017) Effect of high pressure treatment on the color of fresh and processed meats: a review. Critical Reviews in Food Science & Nutrition 59: 228-252.

Notes

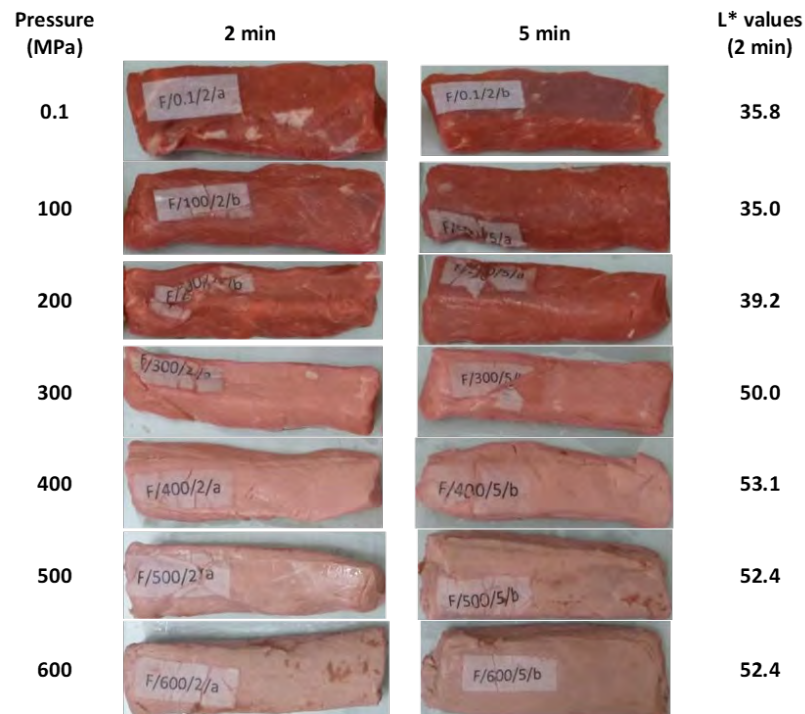


Figure 1
Representative images and L* values (2 min pressure duration) of beef longissimus lumborum samples after high pressure treatment at ambient temperature and 1 h bloom time - 0.1MPa (control - untreated) and pressure treated (100, 200, 300, 400, 500, 600 MPa) for 2 min and 5 min.

L* values (2 min)	Pressure (MPa)	TVC (\log_{10} CFU/cm ²)
35.8	0.1	3.54–5.34
35.0	200	2.00–5.34
39.2	250	1.40–3.74

Table 1
Effect of high pressure processing (HPP) (0.1, 200 and 250 MPa, ambient temperature, 2 min) after storage for 4 weeks at -1°C on total viable counts (TVC) from four 10 cm² surface slices from beef longissimus lumborum.

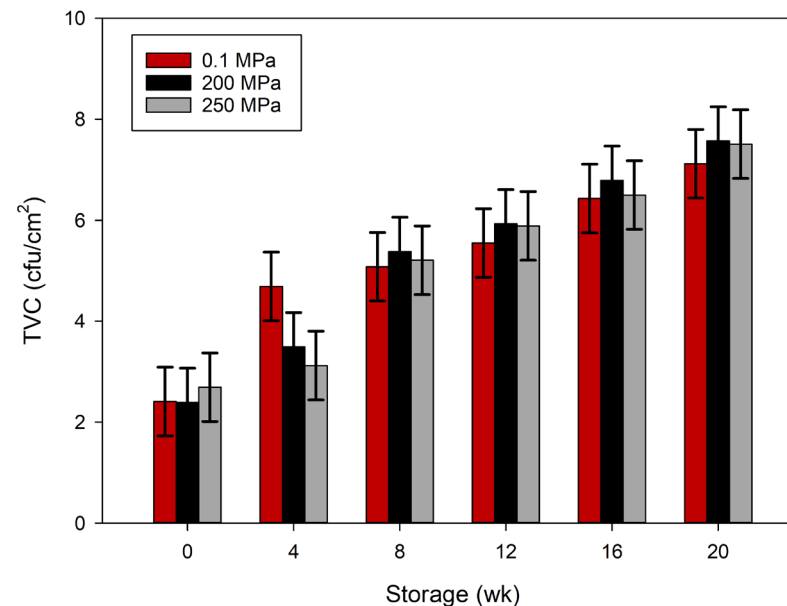


Figure 2
Effect of high pressure processing (HPP) (0.1, 200 and 250 MPa, ambient, 2 min), and storage for 0, 4, 8, 12, 16 and 20 weeks at -1°C on total viable counts (TVC) of four 10 cm² surface slices from beef longissimus lumborum.

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